FIELD WORK IN NATURE STUDY

JACKMAN

JAMES GUILBERT, PRINTER, 140 MONROE ST.

FIELD WORK

—IN—

NATURE STUDY

A HAND-BOOK FOR TEACHERS
AND PUPILS

Through the Senses to the Soul

BY
WILBUR S. JACKMAN, A. B.,

TEACHER OF NATURAL SCIENCE, COOK COUNTY NORMAL SCHOOL,
CHICAGO, ILL.
AUTHOR OF "NATURE STUDY FOR THE COMMON SCHOOLS,"
"NUMBER WORK IN NATURE STUDY," ETC.

PUBLISHED BY
THE AUTHOR

PREFACE.

IN using this book it is suggested that the teacher and pupil look through the questions under the topic selected for study with a view to getting the thought and purpose of the work to be undertaken. With a general idea in mind of what may be done, the topics prepared may then be taken up in that order which will best suit the peculiar conditions presented by any particular locality.

The following books will be found useful as works of reference and for general reading.

ABBOTT, C. C., *M. D.* Days out of doors [New Jersey].
A naturalist's rambles about home [New Jersey].
Outings at odd times.
Recent rambles.
Travels in a tree top.
Upland and meadows: a Poaetquissings chronicle.
Waste-land wanderings.
APGAR. Trees of North America.
BADENOCH, L. N. Romance of the insect world.
BAILEY, L. H. Talks afield about plants and the science of plants.
BALLARD, Julia P. Among the moths and butterflies.
BAMFORD, Mary E. Up and down the brooks.
BATTYE, A. T. Pictures in prose of nature, wild sport, and humbler life.
BRISBIN. Trees and tree planting.
BUCKLEY, Arabella B. The fairy-land of science.
Life and her children.

Thro' ...agic glasses.
Wir ...n life's race, or the great backboned family.
BURR... J. Birds and Bees.
...and Poets.
...n Fields [England].
...usts and wild honey.
...apacton.
...harp eyes, a taste of Maine birch.
Signs and seasons.
Wake-robin.
CREEVY, Caroline A. Recreations in Botany.
GOODALE, G. L. American wild flowers.
GRANT, John B. Our common birds, ...ow to know them.
GRAY. Manual of Botany.
HARDINGE, E. M. Wit... ...s.
HERRICK, *Mrs* ... ...on plant life.
Th... ...life.
... *Jr.* Liberty and a living.
...ow to get bread and butter, sunshine and health, leisure and books, without slaving away one's life.
HUDSON, W. H. Birds in a village.
HUTCHINSON, H. N. The story of the hills.
JACKMAN. Nature Study for the Common Schools.
Number Work in Nature Study.
JEWETT, Sarah Orne. Country-by-ways.
JORDAN. Manual of Vertebrates.
KEELER, H. L. The wild flowers of early spring; a study of one hundred flowers growing in the suburbs of Cleveland and northern Ohio.
KINGSLEY. Town Geology.
KNIGHT, F. A. By leafy ways.
Idyls of the field.
LOOMIS, E. J. Wayside sketches.
LUBBOCK, *Sir* J. The beauties of nature and the wonders of the world we live in.
MABIE, Hamilton W. Under the trees.
MERRIAM, Florence A. Birds through an opera-glass.
MILL. The Realm of Nature.
MILLER, M. My Saturday bird class.

MILLER, Olive Thorne. A bird-lover in the west.
Bird ways.
In nesting time.
Little brothers of the air.
MILNER, G. Country pleasure.
MITCHELL, Donald G. ["Ik Marvel," *pseud.*]. My farm of Edgewood; a country book.
Wet days at Edgewood, with old farmers, old gardeners, and old pastorals.
NEWHALL, C. S. The leaf-collector's handbook and herbarium.
Shrubs of Northeastern America.
Trees of Northeastern America.
NUTTALL'S ornithology. 2 vols.
PRIME, W. C. Along New England roads.
I go a-fishing.
PARKER. How to study Geography.
ROBBINS, Mary Caroline. The rescue of an old place.
ROBERT. The Earth's History.
SAMUEL, Mark. The amateur aquarist.
SANBORN, Kate. Adopting an abandoned farm.
SCUDDER, S. H. Brief guide to the commoner butterflies of the Northern U. S. and Canada.
The life of a butterfly.
SERVISS, Garrett P. Astronomy with an opera glass.
SHALER on Swamps. U. S. Geological Survey, Vol. 10.
On Soils. " " " " 12.
Aspects of the Earth.
Our Continent.
Nature and Man in America,
STURGIS, R. *and others.* Homes in city and country.
SYLVESTER, H. M. Homestead highways.
Prose pastorals.
THAXTER, Celia. An island garden.
Among the Isle of Shoals.
THOREAU, H. D. Autumn.
Cape Cod.
Early spring in Massachusetts.
Excursions in field and forest.
The Maine woods.

FIELD WORK IN NATURE STUDY

JACKMAN

JAMES GUILBERT, PRINTER, 140 MONROE ST.

In advanced science work, a fine laboratory becomes essential; in elementary stages, it is by no means necessary, and in the hands of irrational teachers it may become hurtful. The function of experiment deserves the closest study, and the relation the work done in the laboratory to mind growth should be well understood. Otherwise, experimentation may degenerate into mere juggling with symbols. The way of the child into nature does not lie through a laboratory; nature reaches it without the intervention of any such device. A window garden may be a necessity, but, as a means to the study of plant life, it is a poor substitute for even the most ordinary patch of weeds out doors. Water evaporating from a test tube will entertain for the moment, but it does not lay hold of child life with the power that the same phenomenon does when he sees the mists rolling up from lake and river.

The field lesson, then, rather than the laboratory, is the most important factor in elementary nature study which teachers have to consider. Scarcely a lesson is there in this subject within the range of primary and grammar grades that cannot be better given out doors than in doors, if one can have access to appropriate conditions. In this connection, most teachers, as yet, have everything to learn. It requires no little skill to plan and carry into execution a series of properly related field lessons. It involves not only the systematic, and as far as possible, economic expenditure of time in collecting data, but, also, the question of how to utilize the data in the most intelligent way.

The field lesson is destined to become a source of infinite suggestion and uplift to the whole nature of both pupil and teacher. With children, especially, there must

be no overhaste to reach minute details. These must be reached in the pupil's own time. Broad and general effects are to be kept in mind. Cultivate a general familiarity with things. The soft mingling colors of the whole landscape will have as much in them for the pupil as the brilliant tints of the single flower. The clouds against their back-ground of blue, the shaded woodland, the stream and the hill, can inspire only when seen as related parts of the great whole. In this way will field work lay the foundations for art and create a love for it.

When placed by the field lesson in direct communion with that spirit which infused the lives of those who along nature's paths have led the way to higher things, the child and the man are in the most perfect attitude of mind to appreciate and enjoy the highest and best things ever written. The pupil and the teacher, too, will rejoice to find that even they have something in common with the poets and thus the study of nature and the study of literature, in the mind of the pupil, merge into one.

So, too, will it be with song. Everything in nature that has a voice sings. Music is as much the expression of a natural relation as color is or form. There are times and stages in nature study when a song under the trees, springing from the heart, will do more towards bringing the tree life into the child life than will the specific study of its leaves or the measurement of its height. Nature study is deficient without song, and, for the field lesson with children, it will count for as much to prepare songs for the occasion as it will to provide trowels and collecting boxes.

In short, by placing the child in appreciative, loving contact with nature, the attempt is made to bring him back directly to the original source of all human strength.

If intelligently planned and skillfully executed, field work will do much to break down the barriers which the artificial environment of modern life has erected between the child and nature.

HINTS AND SUGGESTIONS.

Too much must not be expected in the outset from field work in the way of immediate results that will have direct scientific value to the world at large. Even trained naturalists must be content to work very slowly and with great care if actual discoveries of value are to be made. Do not proceed under the theory that the *wonderful* things in nature are always *conspicuous*. Rarely is this the case. The stream at your door has probably done more in earth sculpture than any volcano that ever existed. Rest assured that no region is really devoid of all natural features of interest.

Make an inventory, as complete as possible, of the conditions which seem to you to be unfavorable, so that you may the more easily organize your work. In this list may be included,

1. Your own habit of mind—lack of self-reliance.
2. The attitude of patrons of the school.
3. Means of reaching the field of study.
4. Your own mode of managing the pupils.
5. Your lack of knowledge of nature.
6. Proper time for the work.

Remember that the usual modes of discipline and that the usual school room decorum are out of place in field work. The pupils will ordinarily respect any rational means that the teacher may employ to let them into nature's secrets. Shouts and laughter are indicative of

health rather than depravity, yet when engaged in actual study pupils are not apt to be boisterous. "Keep order" by inspiring the pupils with a desire to learn something and this will result in the necessary self-control.

An area determined by natural boundaries or features is better for study than one bounded artificially; for, it will always stand in the mind of the child as a *unit of its kind.* The extent of the area should be adapted to the capabilities of the pupils; if it be too large the parts will lack coherence and, if too small, not variety enough of detail will be included.

The plan of work may be varied. Single pupils or groups may be assigned to different subjects. The preference of the pupils may well be consulted. In the one lesson few will find it profitable to try to follow more than one line of study.

The initiative of the work should be as informal as possible. The practical and beneficial results of field work may often be gained without sending the school out of doors as a whole. Subjects may be assigned, such as, germination, flowering, opening of buds, erosion, nesting of birds, etc., and the pupils may be required to follow up the teacher's suggestions individually. In the great majority of cases this plan will fail utterly because of the teacher's inability to keep track of the individual. Teachers, as a rule, in the ordinary class-room work see the mass—not the individual; such find that nature study tends to "make their room go to pieces."

It is of great importance to enlist and cultivate the interest of the parents in field work. Disarm their fears for the children by making careful plans for the safety of the pupils, and disarm their prejudices by doing thoughtful work. If necessary, begin with time taken

after school or on Saturday. A campaign of education for the patrons will bring good results.

Make the dynamical side of nature, in whatever department the lesson falls, the center of study. In the past the field lesson has been but little more than a collecting tour. In botany, plants and flowers were carried home and studied chiefly to learn their names by means of a "key." They were then pressed, mounted, and laid away, in many cases, to become the victims of certain pests which infest herbariums. In geology, fossils and rocks were gathered and with much toil carried home to be shelved. Such collections have their place in every naturalist's work, but their interest lies in the story they can tell of themselves and the forces that made them, and they become objects of real value to the pupil, only, as he acquires power to interpret their meaning. In botany, therefore, more fruitful lessons may be given upon the relation of the plant to its habitat; in contrasting those of the meadow with those of the woodland; those of the swamp with those of the upland, and so on. In zoölogy, make a similar study; find why the animals prefer one mode of life to another; what influences the various physical features have upon them; what their relations are to each other and to ourselves; what ones could really be destroyed without our sustaining any loss whatever. In geology, the rocks and fossils contain a marvelous history of untold ages that is not distorted by a single human prejudice! The study of wearing and building agencies, organic and inorganic, give a wonderful insight into geography.

In considering a given area, the pupil must finally acquire and carry in his mind a more or less vivid picture of it. Good judgment would dictate, then, that

such points for observation should be selected at first as will give the most complete view of the whole. Note the direction of the greatest length and breadth. Note the lowest and highest points, the actual elevation of the latter above the nearest stream. Note the streams that flow across it and their direction; the distribution of timber, etc. With the general facts in mind, let a map be commenced; make the drawing to a definite scale.

The following most excellent suggestions as to the technical details to be observed in field sketching have been kindly furnished by Miss Helen B. Gregory, teacher of drawing, Cook County Normal School.

"For out of door study a sketch book or pad and a sketch pencil (Dixon's sketching crayon) are the most practical drawing materials.

"The first step is to choose a subject from the many presented in the field for study.

"*One sketch can only tell what may be seen by looking in one direction without turning the head.* It is therefore necessary to find such a position that the glance includes those facts which are to be noted.

"A simple device for deciding upon the picture to be drawn is to make a *frame* of a piece of card board, the size of a visiting card. Hold this at different distances from the eye, until the frame includes just as much of the view, no more, as will tell the desired story. Keep it in position until you have a clear mental impression of the inclosed picture; note the proportions of earth to sky, the relative proportions and positions of trees, streams or whatever objects are to be included in the sketch.

"The card board frame will also aid in getting the direction of lines.

"Compare the sky lines, the lines formed by the banks of the stream, etc., with the horizontal and vertical lines formed by the edge of the frame. The simplest help in getting the direction of lines is to compare them with the pencil held vertically or horizontally.

"It is a necessity, as well as a privilege, in out of door sketching to eliminate and select. If too many details are drawn, they obscure the main thought and make a confused picture. Look for the salient points of the subject. Having indicated the outline of the sketch, study the light and shade. Select from the many tones of the landscape the few simple broad ones which will indicate distance, middle ground, and near details; occasionally half close your eyes in order to see only the broad masses; work simply to express the thoughts before you. Above all, do not make your drawing compare to any convention idea. In studing one's subject in a landscape, as a rock or a tree, select your points of view with reference to the most adequate representation of the form.

"Stand at such a distance from the object that the whole, or as much of it as you wish to study, can be comprehended at a glance.

"Place yourself also with reference to such arrangement of light and shade as will best bring out the details to be expressed.

"A little practice will enable the pupil to conquer these practical points in out of door work so that the interest will not be distracted from the thought of the subject."

On returning from the field lesson, have the pupils make a record of their observations or in some way summarize the results of the work which they have done in the field. Just what form this exercise should take will depend upon what the subject of the lesson has

been. Sand or clay modeling, with blackboard sketches, would appropriately follow a lesson in almost any subject; drawings, paintings, written and oral descriptions, may then be called for as the material studied may seem to demand. The mode of expression will also be determined by the age of the pupils. Written work is usually the least satisfactory to both pupil and teacher, as such descriptions are less graphic and lack the strength that the pupil can put into the other modes of expression. The main point to be enforced is that each pupil shall have something definite to show as a result of his observations.

It is of the utmost importance for the teacher to see that the pupils properly clothe themselves for the work. In early spring, and in the fall, an extra wrap should always be at hand. The feet, especially, should be kept dry and warm. With a little care on the part of teacher and pupils, no ill effects may be expected, but a single "cold," or a solitary case of sore throat contracted, it may be, through carelessness, will prejudice many well meaning people against field work for a long time.

The proper care of the younger pupils when engaged in field work entails a heavy responsibility upon the teacher. Especially is this so when the trips must be made in part by railroad. Much trouble and care may be avoided by dividing the responsibility with the pupils themselves. This may be done by giving an older child of an advanced grade charge of a younger one of lower grade. This plan will tend to steady the older pupils, and to be the wards of the big boys and girls will delight the younger ones. It is of first importance that the field work be free from danger of accidents, if for no other reason, because any injury to the children would,

probably, and justly too, cause the patrons to put an end to all such work for an indefinite period. Field work, judiciously planned and skilfully executed, does not ordinarily meet with serious opposition from parents.

As a guide for those who wish to organize and carry out field work in connection with nature study, the following topics are suggested for observation and study.

GENERAL OUTLOOK.

In making this general survey of their neighborhood, the pupils should include as much territory as they are able to personally inspect and study. If a natural geographic unit, such as, a creek basin, or ridge, or an area defined by some particular production, can be taken as a whole, the study will be more interesting.

The central idea in the teacher's mind should be the relation of the present condition of life in the area selected to the natural features. How has the present state, social, political and economic been evolved from primitive conditions? When men first form a settlement they stay close to the earth. Instinctively they take advantage, generally in a rude way, of every physical feature, and the direct relationship of man to the soil and country is evident. Later, by means of strength so gathered, the field of operations enlarges, but usually the growth is due merely to man's being able by a refinement of means to take further advantage of natural conditions. Thus, a creek valley may at first furnish only a roadway for a local country thoroughfare; later it may become the route selected for a railroad: A creek emptying into a river may furnish alluvial bottom land rich for purposes of agriculture; but a country highway following the creek to the river makes this junction a convenent shipping point for many square miles of country round, and so, instead of there being a farm at this place,

a town is founded. This, in turn, affects the value of the adjacent region. Out of these relations grow the social and political conditions of the community. The incidental fact of a spring of water often determines the location of a dwelling—a *home*. Whether this spot is capable of being easily beautified by lawns and drives, or not, whether it is of convenient access or not, will determine to an extent that deserves recognition what the home life shall be, and what the character of the citizens shall be that grow up here from childhood. The only original strength that man has comes from an intelligent recognition of the relation which exists between himself and the physical earth considered strictly as a functional thing. The investigation of this relationship is the essential task of *geography*; and, to induce the teacher and pupil to make a study of it, as it may be found in their own community, is the purpose of the following suggestions:

1. What is the most conspicuous natural feature in the landscape about you? Has this feature been slowly or rapidly formed? What has been the agent? Is the agent still at work?

2. What is the general slope of the surface—in what direction and how many feet to the mile? Determine the slope by following the streams. What is the general elevation above sea level?

3. What has formed the hills? The flat lands?

4. What has determined the forest distribution? What is the prevailing timber? Why is it well adapted to the country? What new plants appear as the forests are cleared?

5. What are the native wild animals? Have they

in any way left their impress upon the country? In what ways are they adapted to it?

6. What are the wild animals that formerly inhabit the country? Are there any remains to be found? In what way were they adapted to the country? What *natural* forces led to their extinction? What part did wanton killing play in their extermination?

7. Are there any springs? Are they constant or intermittent? To what extent do they appear to depend directly upon rainfall?

8. What per cent of their volume is increased after one half-inch of rain fall? Determine the flow by leading all the water through a pipe, if possible, and measuring the discharge for a given time.

9. What difference between the minimun and the maximum amounts of water discharged by the spring?

10. Is the water found generally in the country hard or soft? Why?

11. Are there any wells in the country? At what depth is good water obtained? In what kind of rock? Is the water in the well a subterranean stream or a pool?

12. Is the well water hard or soft? Why?

13. What is the underlying rock in the country? Is it stratified? Does it dip? Which direction?

14. Do the irregularities of surface conform to irregularities in the surface of the rocks?

15. What are the causes which tend to produce the nonconformity of the two surfaces?

16. What per cent of the total wealth of the region is derived from mines and mining? What are the chief minerals of value?

17. Are there any valuable beds of clay? What is their origin?

18. What per cent. of the wealth is derived from products of the soil?

19. What determines the nature of the agricultural productions?

20. Are the productions affected by different slopes?

21. Are there any areas that are used wholly for pasturage? Why? For grains? Why?

22. What kinds of farm stock are raised? What conditions affect choice in kinds of stock?

23. Does the fact that the area is upland or lowland affect the choice of stock to be raised? Do the facts of upland and lowland affect the choice of grains to be cultivated? Fruits?

24. What features determined the earliest roadways through the country?

25. How have the lines of the earliest roads been changed? Why is this?

26. How did the early roadways affect the land value?

27. Did the early roadways determine the location of the dwellings, or was the reverse true?

28. What causes have determined the increase in the number of roadways? To what extent is the condition of the roads due to the nature of the surface materials of the country? What natural impediment to their improvement?

29. Are the railroads determined by any of the natural features?

30. Have the railroads changed the relative value of the land of the community?

31. Have the railroads caused the centers of maximum land value to move from where they were when the community depended on the earlier lines of traffic?

32. What per cent of the total wealth of the region is derived from manufactures?

33. What are the natural facilities for manufacturing?

34. What per cent of the raw material used in manufacturing is produced in the region?

35. What are the maximum and minimum values of land in the region?

36. Which affects the land value most, the fertility of the soil or its location?

37. What is the rate of decrease in the value of property per mile from the manufacturing center of the region?

38. What is the rate of decrease in land value per mile from the chief commercial thoroughfare of the region?

39. Does the land value rest ultimately upon the natural features of the region?

40. What natural features have determined the location of the towns?

41. What periods of prosperity, or the reverse, have visited the towns as a direct or indirect result of the natural features of the region?

42. About what area of country may be fairly considered as being tributary to each town? Has this area a natural boundary?

43. Have the natural features of the country determined to any extent the location of the dwellings of the people? The proximity of timber? Of springs? Of streams?

44. Have the natural resources of the country determined to any extent the building materials used in dwellings and other buildings?

45. Has the architecture been made to conform in

any way to the natural necessities of the region? Are the buildings high? Do they have cellars?

46. What nationality originally settled the country? How long since?

47. Did the natural features of the country present any special attractions to that particular nationality?

48. What national peculiarities are still retained by the people? Why?

49. In what respects have the natural features of the region tended to change their national character? What development towards education? In religion?

50. Are the influences in the community producing emigration or immigration?

51. What is the most unsatisfactory condition in the home life of the people? In the community life?

FIELD WORK IN A RIVER BASIN.

In giving the pupils an idea of a river basin and of the work done by a river, it is not absolutely necessary to study a large stream. A brook basin presents many of the features, and frequently all, or nearly all, of the phenomena of erosion found along a river. Indeed, the study of any slope after a rain will reveal a good many results of erosion that are simply produced on a grander scale in a river basin. The study should be greatly enriched by sketching and drawings of more or less diagrammatic character. The diagrams should be constructed on a definite scale. Collections of plants may be made showing their longitudinal and transverse distribution in the basin. Streams play an interesting part in the dissemination of nuts and other seeds. Different forms of animal life, also, find their congenial and appropriate abode in the stream, in the banks, on the lowlands and about the bluffs.

1. What is the area of that part of the basin selected for study? What is its width? The total length of the basin?

2. What is the width of the valley through which the stream flows?

3. Can you form an approximate estimate of the water discharged per hour? Per minute?

4. What is the vertical difference between the low and the high water marks?

5. What is the mean velocity of the stream?

6. Does the water always contain silt? To determine this take a long tube about one to two centimeters in diameter; close one end and fill it with water and let it settle for a few days. Another mode is to put a drop of the water on a clean slip of glass and allow it to evaporate. Look for a residue. Compare with a drop of rain water treated in the same way. Is the water in the stream hard or soft? Why?

7. Make a study of the bottom and shores; make a drawing as nearly as possible to a scale and mark where the various eroded materials are to be found.

8. Can you account for the deposition of the coarse gravel, fine gravel, sand and silt, where you find them? Where do the pebbles come from? Are there any stones among them that do not belong to the country rock?

9. What is the relation of these eroded materials to the curves in the stream, the obstructions on the shores, the velocity of the stream and the width and depth of the stream?

10. What variations in the width of the stream? Can you account for them? Note the varying velocity.

11. What variations in the depth of the stream? Why? Does the velocity vary with the depth?

12. In the drawing of the stream, mark the stretches of shore where there is deposition, and also the stretches where there is erosion only.

13. What causes determine whether erosion or deposition shall take place?

14. Are erosion and deposition in the same places when the stream is at flood hight that they are when it is at its usual stage?

15. Note specially the effect of shore obstructions

upon the erosion of the banks as shown by the curves in the stream. How far down the stream can you trace the effects of a single obstruction?

16. Alongside of the first drawing of the stream make another drawing showing former channels of the stream in the valley where you can trace them? Can you see what causes operated to change the course of the stream?

17. How far from the bed of the stream back to the water parting?

18. Are there terraces on either side? What evidence that these are the results of the stream's action? Can you find any explanation as to how the terraces were formed?

19. What has determined whether there shall be a long slope or a bluff?

20. What evidence can you find that directly shows the river's action clear up to the top of the slope or bluff?

21. What are the forces which tend to destroy the traces of the river action as you go back from its present bed?

22. Have you any means of estimating the length of time that has elapsed during the erosion of the present valley?

23. How high is the source of the river above its outlet? How high above the sea level?

24. How high is that part of the valley which you are studying above the outlet? How far below the source?

25. Make a diagram of a longitudinal section of the valley showing the average rate of descent from source to mouth. From source to sea level.

26. In what part of its course is the descent most rapid?

27. Where are the bluffs and slopes steepest?

28. Is erosion equally active on both bottom and sides? Compare the upper and lower courses of the stream.

29. Where in the stream does the water move fastest? Notice sticks floating on the surface. As the cutting continues in the river bed, how will it effect the erosive power of the stream?

30. Place the eye at the surface of the stream and look across it; is the surface flat?

31. Is the mouth of the river changing its position? Can you find a former mouth? What are the causes of changes? Is there a delta? Why?

32. Is its source changing position?

33. Is the river becoming longer or shorter ?

34. Are any curves being obliterated? Are any new ones being formed? Are there any lakes formed? Are there any marshes due to the stream's action?

35. In what part of the valley is the stream straightest? Why? Where most crooked? Why? Why are alluvial bottom lands confined to the lower part of the course?

36. What produces the crooks in a stream?

37. How does the stream straighten itself?

38. Is the basin growing larger or smaller? Where are the widest bottom lands? Where are the narrowest bottom lands? Why?

39. Is the valley growing deeper? The hills higher?

40. If the present action of the river in this basin is continued what will be its final result?

41. Make a study of any falls or rapids in the stream; what determines whether there shall be falls or rapids?

What is the history of the falls? Are they moving up the stream?

42. Note the entrance of tributaries; are there any delta or bar formations? Can you explain the presence or absence of these?

43. It sometimes happens that the main stream will have high water and the tributary low water, and sometimes just the reverse will occur; note the different results at the mouth of the tributary.

44. Do the tributaries affect the course of the main stream? As the main stream deepens its channel what effect will this have upon the tributaries?

45. How does the vegetation on the banks affect the character of the stream? What are the characteristic plants? How do they spread? How do they maintain themselves against floods? On the whole do they aid or prevent erosion?

46. Does animal life have any visible effects upon the character of the stream? Crawfishes? Muskrats?

47. In what respects has the life of man in the valley conformed itself to the natural conditions offered by the stream?

48. Starting at the source of the stream, can you notice any regular increase in the scope of man's work which corresponds to the growth of the stream? Compare occupations in different parts of the course on the two sides of the stream.

49. What are the possibilities and necessities for irrigation? For water power? Navigation? Are there any dams on the stream? Why?

50. What additional natural advantages at the junction of a tributary with the main stream?

51. What has been the most important natural features in determining the location of the towns in the valley? In locating the houses of those who live outside the towns?

52. What industries are made possible by the stream? Are any debarred by it?

53. What part does the stream and the valley play in determining highways for travel to different parts of the country?

54. What are the meteorological and climatic influences of the stream and valley? Do the first frosts of autumn occur earlier or later in the valley than on the hills? Does the direction of the stream affect the agriculture of the region?

55. Do the last frosts in spring occur later here than on the hills?

56. What is the rainfall in the valley? Compare with that a few miles back from the valley. Does the valley affect the course of the storms?

57. Is vegetation earlier or later in the valley in the spring? Does the direction which the river flows affect this?

58. What grains grow best on the bottom lands? Why?

59. What fruits grow best in the valley? Why?

60. The river basin here studied is what part of the area of the next larger basin of which it constitutes a division?

FIELD WORK ON SOILS.

In this study it is most instructive to select an area sufficiently large to be somewhat typical of the region. It should include, if possible, the prominent natural diversities of surface, such as, highlands, slopes, lowlands, woodland, open areas, tilled, and if possible, virgin soil. The latter is, of course, the true soil formed by natural agencies and in most places it will be difficult to find. The area should be chosen, too, with reference to varying degrees of natural fertility. Samples of soil at various depths may be obtained from borings of an ordinary ground auger and sections may be seen in railroad cuts, in landslides, in the face of bluffs worn by streams, where trees have been uprooted and in excavations made for buildings, in digging wells, and for other similar purposes. An instructive section of the soil may be prepared by nailing together three boards four or five inches wide and of any desired length so as to form three sides of a rectangular box. Make the fourth side of glass and stand the box on one end which should be closed. The various strata formed in the soil, such as clay, sand, loam, may be placed in the box in proper order and in such amount as to show the relative thickness of each stratum. The same thing may be shown on a smaller scale in an ordinary glass fruit jar or in a piece of glass tubing.

1. What evidence is at hand as to the origin of the soil?

2. From what different sources has it been derived? How much of it is derived from the underlying rock? How much has been deposited by some means upon the country rock? What part, and how much of it, is due to plant life? Has animal life affected it?

3. To what depth has decayed vegetation mingled with the soil in the woodlands? In the open areas?

4. What are the chief agents at work in mingling the organic with the inorganic portions? Examine as nearly pure vegetable mold as you can find; is it wholly organic? Heat in a crucible a given weight of dry soil; what part of its weight is lost? Can you find any evidence of organic elements in the deeper layers of the earth? At what depth do traces of the organic elements disappear?

5. What change takes place in the character of woodland soil when the forest growth is cleared away?

6. How does the depth of the soil on the higher ground compare with that on the lowland?

7. To what extent is the lowland soil derived from the upland? What are the means by which the lower levels are replenished by supplies from the higher?

8. What is the nature of the soil where erosion is most rapid? What are the conditions of soil most favorable to landslides?

9. Where lowlands are subject to overflow, can you etimate the amount of new soil material deposited in a year?

10. Are there any bare rock areas without soil? Is the rock weathering? What becomes of the weathered material?

11. What are the conditions which seem to determine the fertility or sterility of the soil?

12. What new plants spring up spontaneously when the woodland is cleared? What plants disappear entirely?

13. How close to the surface does the bed rock lie where its effects are first seen on vegetation?

14. What kinds of soil soonest show in vegetation the effects of drought? Why?

15. During a season when there is abundant moisture, what differences in soils can be noticed in the growth of vegetation?

16. What plants succumb soonest to drought? What plants survive drought best? What adaptations in the latter that are absent in the former?

17. Can you determine any of the important chemical elements of the soil? What is their origin in the soil?

18. Can you determine the chief physical constituents? What is the proportion of the different physical or mechanical constituents?

19. What effect is tillage having upon the soil, in fertility and in the erosion of the surface?

20. What crops are best grown on the uplands? On the lowlands? Why the difference?

FIELD WORK ON A SWAMP.

It should be borne in mind that the fundamantal condition for a swamp is not that there shall be an excessive amount of moisture, necessarily, but that some condition shall operate to prevent alternate wetting and drying. This may be brought about by the presence of a forest, the leaves and other decaying material of which delay the passage of water; by the peculiar nature of the strata underlying the surface; by the fact that the area is subject to frequent and regular overflow as in tidal marshes and along river bottoms; others are the result of slowly filling lakes; and still others are of delta origin. Each swamp will have some distinctive feature that may be traced to the particular cause of its formation. Owing to the retarding effect that water has upon the decay of plants that become submerged after dying, swamps are all marked by soils rich in organic materials. The result of the indefinite preservation of the partially decayed plant materials is the accumulation of vast beds of muck or peat. The proportion of mineral matter which this contains will depend upon the origin of the swamp; those along streams will have more, those about lake shores or in filling lakes will have less.

The animal life of a swamp is no less interesting than the plant life and it is of considerable importance. Swamps usually abound in crustaceans. The compounds of lime of which the shells of these animals are composed

are mingled with the soil as decay overtakes them and it is thus made very fertile for such agricultural products, the grains for example, as need these materials. The process of reclaiming swamp lands, whether they are in forests or open grounds, whether upland or lowlands, is interesting from the standpoint of both the engineer and the farmer.

1. Study carefully the conditions under which the swamp is formed. What is the degree of slope of the general surface of the swamp and the surrounding country? How is the swamp drained?

2. What caused the depression occupied by the swamp? What seems to have been the initial step in the formation? Is the surface still being lowered?

3. What is the area of the swamp? Is this increasing or diminishing? Does it receive sediment from the adjacent higher ground?

4. What is the relation of the swamp to the nearest stream or lake? Is this swamp subject to overflow? How often?

5 To what extent is climate, temperature and rainfall, responsible for the swamp?

6. What has vegetation done?

7. Is the swamp subject to droughts? To what depth is it ever dried out?

8. Why are swamps not formed in all flat lands?

9. Examine some of the mud; what is its color? Does it consist of sand grains? What is the relation of the underlying rock to the swamp?

10. Is it like the clay mud found in drier places in times of wet weather? Dry some of it, and compare with clay and sand.

11. Using a pole as a probe, can you tell how deep the muck is?

12. Where does the soft material come from that is not washed in from the adjacent higher ground?

13. Can you find the remains of either animals or plants in the mud? Do they seem to be decaying? What animals inhabit the swamp? Are they peculiar in any respect?

14. In some of the great bogs of the world, some marvellously well preserved specimens have been found. "In 1747, in an English bog, the body of a woman was found, with skin, nails, and hair almost perfect, and with *sandals on her feet*. In Ireland, under eleven feet of peat, the body of a man was found *clothed in coarse hair-cloth.*" (Le Conte.)

15. Can you tell what effect the vegetation that now covers the swamp has upon it?

16. Can you tell whether the vegetation ever differed from what it now is? Was it a swamp when the vegetation differed?

17. Does the vegetable matter decay as it falls to the earth each year.

18. When the black material of which the swamp is composed is dried and ignited, will it burn?

19. If it burns, what does this show its history to be?

20. Peat swamps are found in Ireland, France, and many other parts of middle and northern Europe. They are much more abundant in the north than in the south. They are rarely found south of 36° latitude.

21. The Great Dismal Swamp of Virgina is an exception. It is forty miles in length, north and south, and twenty-five miles wide. There is a depth of fifteen feet of vegetable matter.

22. Why is it that peat bogs are much more common in the north than in the south?

23. What kind of climate is best for them? Why? The peat formation in the Dismal Swamp is rendered possible by the large trees with dense foliage which grow there. Can you see a reason?

24. What happens to vegetation that falls to the ground in southern or very warm countries?

25. Can you picture to yourself how it would be possible for a peat-bog to be transformed into a coal bed?

26. Where is peat now used largely as fuel?

FIELD WORK ON A LAKE SHORE.

THE following suggestions are designed especially for the study of that part of the shore of Lake Michigan which lies east of South Chicago. But a similar line of thought may be followed for lakes and lake action in general.

The question as to how the bed of the lake was hollowed out is one of interest and importance, though the area included may be so large or other conditions may be present, which will render it difficult to find a solution to the problem. It is generally agreed that the beds of the great lakes were gouged out almost wholly by glacial action. This is true of the great majority of the lakes in North America. Compared with river action the function of the lake is insignificant and unimportant. The study is interesting chiefly because from it may be derived something of the early physical history of the region as shown by the lines of former shores.

1. What is the general direction of the present shore line? Can you find evidence of a former beach farther inland? What was its direction?

2. Is the shore now a building or a wearing beach? To answer this it will be necessary to study a considerable length of shore line. Note the bluff formations. Do they indicate wind or water origin?

3. Note the peaty formations reaching out into the

lake; what do they indicate as to the nature of the work now going on?

4. Note the deposition of the different materials; why is fine sand in one place and coarse gravel in another? What causes the sorting of material?

5. As the waves roll up and back on the beach, listen to the slight rasping sound as the stones grind upon each other.

6. Note the piers built out into the lake; why the difference in shore structure on the opposite sides?

7. Look about these piers for ripple marks in the sand? What are the exact conditions here which produce ripple marks?

8. What prevents the formation of ripple marks elsewhere on the shore?

9. Fill a bottle with some lake water and allow it to settle. Note the amount of silt. How many different kinds of rock found among the pebbles on the shore?

10. What is the chief agent in the formation of the sand dunes near the shore? What has determined their direction?

11. What part does plant life play in their formation? In their protection?

12. Do they show any stratification? Upon what kind of formation do they rest?

13. Where did the sand come from that forms the dunes?

14. Note the succession of low parallel ridges which cross the country about one-half mile apart for a distance of several miles back from the shore. What is their direction? Compare with the direction of the present shore line?

15. Note the vegetation on these ridges; compare with that found in the intervening swamps.

16. What is the most probable history of these ridges? Look for their structure in road cuttings.

17. What is the probable origin of the swamps? Are they still becoming more swampy or less so?

18. What is the most probable relation which both ridges and swamps bear to the lake?

19. What can you conclude, as to the lake history, from a study of this region ?

20. Study the lake, as it now is, in its relation to the old outlet to the south.

21. What must be the ultimate fate of a lake if the outlet remains open?

22. Under what conditions will bogs form along lake shores?

FIELD WORK ON A CLIFF.

ANY one who desires to read something of the physical history of a region is fortunate, indeed, if he can have access to any considerable vertical section, such as is shown in a cliff a few hundred feet in hight. The face of a cliff presents an unbiased record of geological operations covering, usually, vast areas and involving inconceivable lapses of time. The teacher must be patient in working out the facts presented, for the mind of the pupil will be taxed to its utmost in its endeavors to grasp the meaning of what may there be found.

The opportunity thus presented to read the grand and beautiful history of earth is not only wholly neglected by most people, but its presence is not even suspected by them. If the teacher succeeds in but directing the pupil's thoughts somewhat towards this treasure-house of wonder and interest, he will do him an imperishable good.

The formation of cliffs on a small scale may be witnessed almost anywhere that erosive action is to be seen at all. A small rivulet will have its bluffs of greater or lesser magnitude in which the stratified materials may appear. As this miniature bluff crumbles the formation of the talus will be seen and the subsequent action of the stream in carrying this away will complete the line of descent which upland materials are gradually making towards lower levels.

In lieu of natural exposures or in connection with them it will be found of great interest to study the sections shown in railroad cuts. It is especially interesting to note the relative rate of weathering of the various strata in such exposures. Quarries should be visited and every effort should be made to work towards a definite idea of the length of time represented by the parts exposed.

1. By what agency has the cliff been formed? Is the force still operating?
2. Note the mode of weathering; what is the most active agent in weathering?
3. Look for hard and soft portions in the face of the cliff?
4. How is the form of the slope affected by the relative position of the hard and soft layers? Under what conditions will the cliff weather into a long gradual slope? Under what conditions will it remain cliff-like?
5. What gives rise to the *talus* or mass of fragments at the foot of the cliff? What becomes of this talus? What kind of vegetation first gets a hold on the talus? Where in the talus is the least soil?
6. How does a surface weathered by wind, frost and rain differ in appearance from one eroded by running water?
7. What are the mineral elements in the rock of the cliff?
8. Are the mineral elements affected by the chemical action of the atmosphere?
9. What is the mineral element in the cliff that yields easiest to the chemical agencies?
10. What is the mineral element in the cliff that yields easiest to physical agencies?

11. Can you form any estimate as to the rate at which the cliff is weathering? Hunt for an area of the same rock that has been exposed for a known time in an old quarry and estimate the rate of erosion by the materials that can be gathered and measured.

12. Are there any plants growing upon or clinging to the cliff? Is their effect destructive or protective? What are the plants that first take hold? Why?

13. Is the *talus* at the foot of the cliff changing into soil suitable for vegetation? For cultivation?

14. What promotes and what hinders the transformation of the *talus* into soil?

15. Is the cliff itself likely to be covered by the accumulation of the *talus*?

16. Are there any fossils to be found in the cliff? What light does either their presence or absence, their regularity or irregularity of distribution throw upon the history of the cliff?

17. If the cliff is on one side of a valley or ravine, can you find the same rock structure on the opposite side? What does the presence or absence of similar structure on the opposite side show?

18. To what depth can you probe the fissures in the cliff face? Are they vertical or horizontal?

19. What are the agents at work forming the fissures?

20. Are there any caves or cave-like excavations in the cliff? Why?

21. Do any animals inhabit the cliff? How do they fasten their nests or dig their dens?

22. Have you any means whatever of knowing how much time is represented in the building of the strata exposed at this place?

23. Have you any means of estimating how much time has been consumed in cutting through the strata here exposed? It is estimated that the Mississippi Basin is lowered, on an average, one foot in five thousand years.

24. Can you tell from the fossils found and from their arrangement how many periods of uplifting and submergence are represented?

25. Are the fossils of land and water forms found mingled?

26. Is there any evidence as to whether the water was deep or shallow, running or still, during the periods of submergence?

27. Was the submergence sudden or gradual? Was it due to the sinking of the land or the rising of the water?

28. Are there any traces of swamp formations in the cliff?

29. Do the fossils that are found indicate dense or scattered growth? Is a great variety of forms indicated by the fossils?

30. Do the fossils found, either animal or plant, indicate any relationship with forms found at the present time in the same locality?

FIELD WORK IN BOTANY.

The suggestions given under the head of Zoölogy apply equally well to this subject. The aim should be to cultivate a familiarity on the part of the pupils with the plants as they grow in their natural environment. Flowers when nodding and waving on their parent stem are far more beautiful than they are in vases or pressed in a herbarium, and children should not be encouraged in random and wanton destruction, especially when they have neither the means, the desire, nor the ability to properly preserve the specimens. Community life, and individual life in isolation furnish many interesting contrasts in the same plant. It is not difficult to find *Botanical Centers* about which the thoughts of the pupils may be directed. A single tree may be found sometimes, which, owing to its favorable location for the dissemination of its seeds, has become the founder of a colony, the members of which may illustrate some of the modifications of the individual which are necessary in community life. A stream's bank, a slope, north or south, a marsh or a bit of open upland, each will present interesting features peculiar to itself.

I. *Distribution of Plant Life.*

1. Where is plant life most vigorous, upland or lowland? In marshes or on dry ground?

2. What location has the greatest variety of plant forms? What location has the least variety?

3. Where is the greatest variety of forms, in woodland, or in the open spaces?

4. What plants are found on both marshy and dry land?

5. What plants are found both in woods and in cleared land?

6. What plants are found on upland and in lowland?

7. What plants are found along the courses of streams but not elsewhere?

8. What plants are found along roadsides chiefly?

9. What plants seem to be favored by northern slopes or exposures? By southern?

10. What kinds of aquatic plants can you find?

11. Can you find any evidence that the streams have been instrumental in distributing the plants, by seed or otherwise?

II. *Forms and Habits of Plants.*

1. Of all the various plants examined, what per cent may be classed as *annuals?*

2. What per cent may be classed as biennials?

3. What per cent may be classed as perennials?

4. Does any particular locality seem to best suit the annuals? The biennials? The perennials?

5. What per cent of the plants examined has tap roots?

6. Are the plants with tap roots confined to any particular soil or locality—wet or dry, upland or lowland, woods or open ground?

7. Where there are tap roots, what ratios can you find between the length of the stem and the length of the root in the various plants?

8. Where there are tap roots, what ratios can you find

between the depth of the tap root and the radius of the spread of the branch roots?

9. Where there are tap roots what ratios can you find between the radius of the spread of the roots and the length of the stem?

10. What is the ratio, where there are tap roots, between the radius of the spread of root and the radius of the spread of top or branches?

11. Where there is no tap root, what ratios can be found between the radius of the spread of roots and that of the spread of top? Between the spread of roots and the hight of the plant?

12. Does the character of the soil seem to modify the form of roots?

13. Does the character of the soil affect the spread or depth of roots in the same plant found in different localities?

14. What per cent of the different plants found grows from bulbs? What per cent from underground stems?

15. What environment seems best for bulbous plants? For those with fibrous roots?

16. What environment seems to best suit trailing stems? Upright stems?

17. What per cent of the different kinds of plants you find, spreads by runners? The climbers and twining plants are what per cent of the whole?

18. Will stems, normally upright, take root if brought into contact with the earth?

19. What are the mutual effects upon the two plants of a vine climbing over a tree, bush or shrub?

20. What causes operate to determine the normal form of the tops of plants, including all bushes and trees?

21. What causes operate to modify the normal shape of the tops of plants?

22. What are the well defined differences between trees or plants growing in isolation and the same kinds growing in close community?

III. *Inflorescence.*

1. What plants flower earliest in Spring? Can you arrange the plants in your locality in a list in the order of flowering?

2. What is the location of the early flowering plants, in the woodlands or open fields?

3. What per cent of the early flowering plants are the annuals? Biennials? Perennials?

4. Where is the nourishment stored that gives the early flowering plants their start in the spring? Compare Hepatica, Bloodroot, Spring Beauty, Jack-in-the-Pulpit, Dutchman's Breeches, Anemone, Dandelion, Buttercups, Crowfoot, Everlasting, Violets and any others that may be found in your locality?

5. What is the prevailing color of the flowers in your vicinity? Of those in woodland? Of those in open fields?

6. What is the prevailing color of the early flowers? The late flowers?

7. Are there any flowers that open for one day only?

8. Are there any flowers that open for several days but close at night? That remain open day and night? What per cent in each case?

9. What is the prevailing color of the flowers that open in the night, only, or at least late in the day or in the evening?

10. What is the prevailing color of the flowers that are open at night? Of those open in the day time only?

11. What forms of inflorescence can you find? (See Gray's Botany for key to terms.)

12. What flowers in your vicinity are visited by bees? What per cent of the whole?

13. What plants are frequented by ants?

14. On what plants do the flowers stand upright? Are they self-fertilized? If not how is self-fertilization prevented?

15. What plants have drooping flowers? How are these fertilized?

16. Sketch the stamens and pistils of the different *Orders* of plants in your vicinity showing, as far as possible, their relation to each other in fertilization.

17. Do the structure of the flowers show any adaptations to insect life, either favorable or the reverse to the latter?

IV. *Fruit.*

1. What is the earliest date at which any of the plants in your vicinity mature seeds?

2. Are the earliest flowering plants earliest in maturing seeds?

3. What plants uncultivated in your vicinity have close relations among the cultivated plants?

4. Note the contrivances for distributing the seeds; what per cent depends upon the wind? Upon birds or other animals? Upon structure of pods? Upon burrs, hooks, prickles, etc?

5. What fruits are stored up as food by some animals? Is this favorable or unfavorable to plant life?

6. What per cent of fruits is made more conspicuous by ripening? What per cent is rendered less conspicuous?

7. What per cent of the fruits becomes more palatable to animals on ripening? What per cent less palatable?

8. Which seem to be the best seeds, on the same plant, those maturing early or those maturing late?

9. Do any of the seeds begin to germinate in the fall?

10. Can you form any estimate as to how many seeds are produced by a single plant of any species examined?

11. Can you form any estimate of the ratio between the number of seeds formed and the number of plants that mature from them?

12. Can you find any special means by which seeds plant themselves?

13. How many different *Orders* of plants are represented in your vicinity? How many species?

14. What are the leading characteristics of the *Orders*?

FIELD WORK IN ZOÖLOGY.

PERHAPS the most natural classification which children make of living things is the division into the injurious and the beneficial. This is certainly not scientific, neither is it an easy classification to make from the standpoint of truth; owing to its practical side, however, it will not be amiss to allow the pupils to use it as a basis in the beginning.

The central point of interest in the study of either the animal or the plant is in its adaptation to the features of its environment. The plasticity of the organic form in adjusting itself to almost every nook and cranny on the globe, in air, water, on the solid earth as well as within it, sometimes isolated and again massed into dense communities living with each other, for each other and upon each other, and the resulting endless diversity in form and habit, but the absolute unity in function are at once the marvel and the mystery of the living thing. The pupil should, therefore, continually seek for that relation which subsists between function and structure, and from this as an effect, look into the environment for a cause.

In field work, study the animals in their relations to each other and to plants. As in the study of the surface, it is best to seek for geographic units, so, in this case, try to find some zoölogical center. It may be that a single tree will provide most interesting zoölogical ma-

terial the year round. An ant hill in an open field stands, in itself, somewhat as a whole. The animal life about an old decaying log will prove much more fruitful in study than will twice the number of specimens studied each by itself. Almost any stream, or pool, or pond will furnish several such centers. There is life along the shore, dependent secondarily, for a time at least, upon the water, as for example, the frogs. There is life in the water, dependent secondarily upon the shore, for example, the turtles. There is life at the bottom of the stream, and dependent upon the bottom, as in the case of the crawfish. The myriad forms of fishes illustrate the life dependent chiefly upon the water itself. Each group forms a center for study but it becomes more interesting when its relations to the others are observed.

For the purposes of field work, therefore, it is believed that it will be much more useful to plan the lessons around *zoölogical* centers than to plan it in accordance with the usual text-book classification of animals. It is with this in mind that the following suggestions are given.

I. *Animal Life Upon Plants.*

1. Select some tree, or a group of trees for study; how many different kinds of insects can you find on the leaves?

2. Do they gnaw the leaves or suck the juices?

3. Are there any that lay their eggs upon the leaves, but do not use them for food? Look for clusters of eggs on the under side. When do the eggs hatch? What insect form comes from the egg?

4. When the eggs hatch, are the young the subjects of any parental attentions?

5. Can you find any insects that sting the leaves? The branches? The buds?

6. Note carefully the result of the stings in each case. Open up the wounds; can you find the eggs?

7. What insects kill outright the member stung?

8. What insects transform the member into galls? Make a collection of the different kinds of galls. Examine the knots and other malformed parts of the plants.

9. What per cent of the leaves is stung or otherwise injured by insects?

10. Are there any insects that live in the ground about the roots of the plant but which climb the trunk or stem? What insects are they? How do they use the plant?

11. What insects infest the bark?

12. Pull up plants of various kinds and look for insects about the roots. If accessible, examine the roots in a hill of corn. Look for ants about corn roots. Can you find any root lice about the corn? Can you see any relation between ants and these lice?

13. At what time of day are the insects most active? What becomes of them at night?

14. How many different kinds of insects can you find that visit flowers? Do they all visit for the same purpose?

15. How many different kinds of insects visit the same flower?

16. In what respects are the insects that visit the same flower alike?

17. Do the insects have any need of protection from enemies? Compare the coloration of the insects with that of the flower.

18. What butterflies can you find on the flowers? Do

butterflies of the same kind visit the same kind of flowers? Find out the favorite flowers?

19. Do the moths visit the flowers? Which flowers appear to be the favorites of the insects?

20. Do insects visit the flowers at night?

21. Keep a look out for ants attending their "cattle" on some of the plants.

22. Do any other living things make use of the tree or group of trees which you are studying?

23. Can you find any squirrels' nests? What favors their location? Look after the food supply and the matter of protection.

24. What birds tenant the grove you have selected for study? How many different kinds of nests are there?

25. Which of these birds are injurious to the interests of the people in the neighborhood? Which birds are beneficial?

26. Look for peculiar habits in nesting. What devices are employed in concealing the nests? How many eggs do the birds lay?

27. Is the coloration of the eggs protective? In what per cent of instances?

28. Is the coloration of the bird protective?

29. When is the nest built? When are the eggs laid?

30. When is the brood hatched? How long before the young ones fly? Is there a second brood? Is it in the same nest?

31. Do both male and female birds wait upon the young ones? What is the food of the young?

32. Do the young and old go together when the former are grown?

33. Note the contrasts in color between the young birds and the old ones. Between the male and female birds.

34. What changes in plumage or color as the season advances?

35. What birds remain the year round?

36. What birds belong to this locality? Make a calendar showing the time of nesting, hatching and migration of the different birds.

37. Are there any reptiles found in this locality? What is their food? Are they venomous?

38. What enemies do they have to contend with?

39. What becomes of them in winter?

II. *About a Stream or Pond.*

1. How many different kinds of animals make up the shore life?

2. What animals live part of the time on the shore and part of the time in the water? Study the habits of the shore birds. How are they adapted to a shore life?

3. How many different animals live on shore but get their food from the water?

4. What animals live in the water, partly, but depend upon the shore for their food?

5. What animals burrow in the banks? If possible, find the opening into a muskrat's burrow? Is the den above or below the water level?

6. What is the food of the muskrat?

7. Make a study of the kingfisher. Where does this bird nest?

8. Watch to see it take its food. Is the food masticated, or picked to pieces, or swallowed whole?

9. Make a study of the life of a frog; how and where does it get its food?

10. Why is jumping a better mode of locomotion for a frog than running?

11. What are the frog's enemies? Has it enemies in the water as well as on the land?

12. Is its coloration of any importance to it?

13. What animals live secreted among the stones at the bottom of the water?

14. What enemies do they have to avoid? What is their food?

15. In the early spring watch for the mother crawfishes with the eggs attached. Later, watch for the young ones.

16. Find out how and when the crawfish sheds its shell.

17. Have the crawfishes community life?

18. How many different kinds of turtles about the water? Do they find their prey on land, or in the water? Are they social creatures in their habits?

19. What water snakes can be found in the stream?

20. What becomes of the various forms of life found here in winter?

III. *Ground Life.*

1. Examine the animal life that may be found about an old stump or decaying log. How many different kinds of animals do you find in the colony?

2. Do these animals live in harmony with each other? What means of attack and defense have they?

3. How do they make their way into the interior of the log or stump?

4. What part of the whole life about this log or stump is insect life?

5. The beetles are what part of the whole? In what respects are the beetles fitted for this kind of environment?

6. Make a study of the spiders; how many different kinds can you find?

7. What is the food of spiders? How many different forms of webs can you find?

8. What insects do the spiders use for food?

9. What insects do the birds seek for food?

10. Look for insects in the different stages of metamorphism in and about old logs, in newly plowed fields and anywhere that lower layers of the soil are exposed.

11. At what depth does insect life cease to exist?

12. Make a study of the earthworms in different localities; where are they most abundant?

13. Study their habits as shown in wet and dry weather; in day time and at night.

14. Look about old fences and logs and other damp secluded spots for toads. *No danger of warts.*

15. When are toads most active? Try keeping one in the door yard for a pet. Feed it with earthworms or insects. Provide a small dark box or a hole under a stone in a shady spot for a day time retreat. A toad, properly treated, will become as tame as a kitten. Turtles and many other animals, most of them, in fact, respond to humane treatment, and in their mute appreciation of kindness do not a little to soften the human heart.

16. What different kinds of animals burrow in the earth? Where is their food supply?

17. What animals in your neighborhood are carnivorous? Note their teeth and claws.

18. What animals are herbivorous? Contrast their structure with that of the carnivora.

19. What animals hibernate in winter wholly or partially?

20. What animals migrate in autumn?

IV. *Miscellaneous.*

1. Are the animals raised in the country now, for stock purposes, related in any way to the wild animals that once inhabited the region?

2. What animals are totally different from the wild ones?

3. What special care do the domesticated animals need? How does the lack of care and attention affect these animals?

4. How has the pasturage been changed from what it once was to suit the domesticated animals?

5. Among wild animals, how do the various kinds act as checks upon each other.

6. Is the same thing to be observed among domesticated animals?

7. What means do stockmen employ to modify the mutual influences of the different kinds of stock?